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HOW CAN SEXED SEMEN BE USED IN COMMERCIAL BEEF HERDS?[1]

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Introduction

Gender selected or sexed semen has been commercially available to the dairy industry for almost a decade. However, sexed semen from beef bulls became commercially available only recently. The availability of sexed semen from beef bulls along with concerns about success of the technology at the ranch level has limited the use of sexed semen in purebred and commercial beef operations. Recent changes in semen availability combined with current studies with sexed beef semen are providing insights to the uses, limitations, opportunities, and challenges of this technology.

Increased sorting capacity allowed the number of beef bulls with gender selected semen available to increase exponentially over the last five years. For the major US AI studs, the number of beef bulls with gender sorted semen available increased from 0 to 70 from 2008 to 2011 (Hall, 2011). Sexing Technologies, the major semen sexing company, lists 28 sires with sexed semen in their catalog. In addition to sex sorting operations at all major bull studs in the US and several other countries, Sexing Technologies now has custom semen sexing operations in five locations across the US. However, the number and genetic diversity of beef bulls with sexed semen available is limited compared to the offering of AI beef bulls with conventional semen. While not an overwhelming selection of bulls and genetics, there are now sufficient numbers of beef bulls with sexed semen to begin to meet the needs of the seedstock sector, and address the wanted traits for the commercial producer.

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Recent research from several universities indicates that sexed semen may have a place in commercial beef production. This paper discusses the potential and limitations of adopting use of sexed semen in commercial operations.

WHAT TO EXPECT WHEN USING SEXED SEMEN IN BEEF CATTLE

Pregnancy rates are decreased 10 to 20 % compared to conventional semen. Nebraska researchers (Deutscher et al., 2002) reported a 3% to 13% reduction in AI pregnancy rates when using sexed versus conventional semen in yearling beef heifers. Similarly, other researchers reported reductions in pregnancy rates when using sexed compared to conventional semen in beef heifers. (Rhinehart et al., 2011 - 4% to 38% reduction; Meyer et al., 2012 – 17% reduction).

Cows and heifers respond similarly. Rhinehart et al., (2011) saw no difference in the performance of sexed semen in heifers vs. cows. However, the AI pregnancy rates to sexed semen were only in the 30 to 35% range. At the University of Idaho Nancy M. Cummings Center, we bred postpartum lactating beef cows with either sexed (n = 235) or conventional (n = 507) semen over three breeding seasons (Hall et al., 2010; Figure 1). Pregnancy rates to sexed semen averaged 52% (range 48% to 58%) while pregnancy rates to conventional semen averaged 58% percent (range 52% to 69%). In year 3, the same bulls were used for sexed and conventional semen, and there was a 20% difference in pregnancy rates to sexed compared to conventional semen. These results were encouraging especially when our lowest pregnancy rates with FTAI with sexed semen still approached 50%. However, all animals used in these experiments were mature cows and only a limited number of bulls were represented.

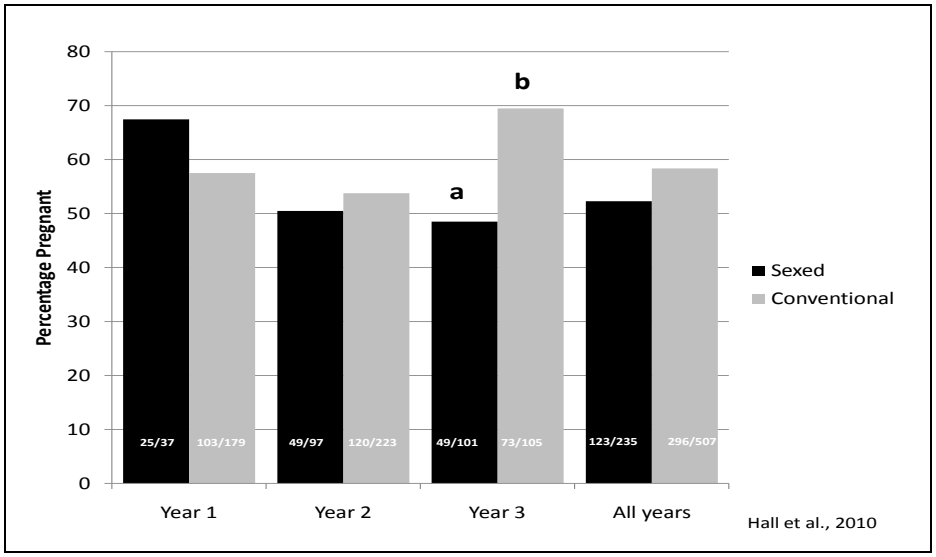

Figure 1. Pregnancy rates to X-sorted or conventional semen in postpartum beef cows. Year 1 cows receiving sexed semen bred 12h after estrus, and conventional cows bred after estrus or fixed time AI. Year 2 & 3 all cows bred by fixed time AI. [a,b] Pregnancy rates differ ($P < 0.05$).

Fixed time AI systems work with sexed semen, but inseminating cows that express estrus is best. We inseminated 780 cows with sexed semen in a study investigating the effects of timing of insemination in a FTAI system on pregnancy rates. Over the 3 years, we

achieved a 38% pregnancy rate to FTAI. Also, other laboratories report reductions in AI pregnancy rates of 9% to 33% for cows bred by fixed-time AI with sexed semen compared to those inseminated with conventional semen (Rhinehart et al., 2011, Sá Filho et al., 2012).

Cows or heifers that are inseminated based on estrus or exhibit estrus before FTAI have greater pregnancy rates to sexed semen (Hall et al., 2010; Meyer et al., 2012). At our research station, we observed a further 10% to 20% decrease in pregnancy rates in postpartum beef cows inseminated with sexed semen without an observed estrus. Meyer and co-workers (2012) reported up to a 43% reduction in pregnancy rate in heifers with no observed estrus that were mass inseminated compared to heifers bred after observed estrus. Expression of estrus might be used as a criterion to select animals to be AIed with sexed semen.

Expect more variability in success. Several groups have observed that there is considerable variation in pregnancy rates from bull to bull with sexed semen (Hall et al., 2010; Meyer et al, 2012; Figure 2).

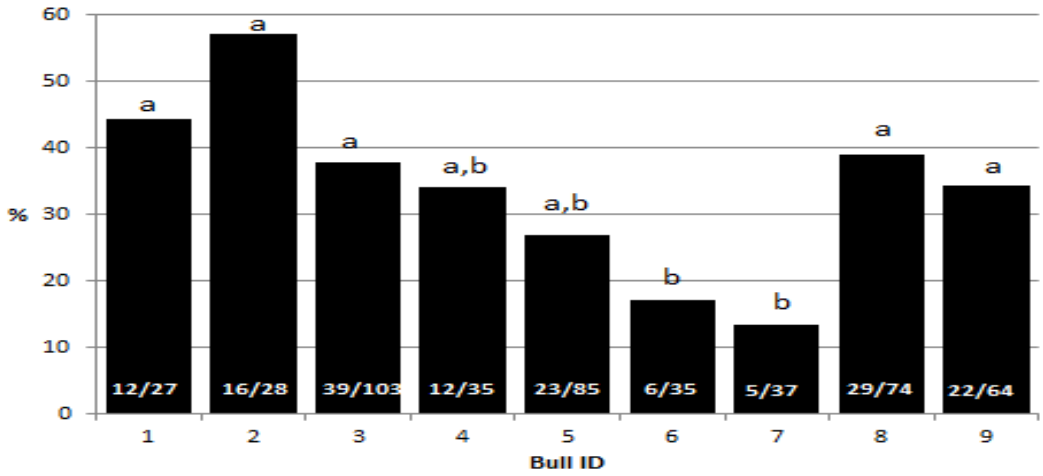

Figure 2. Variation in pregnancy rates to sexed semen from different bulls used at the University of Idaho in 2011 & 2012. Proportion of cows pregnant is indicted on bars. a,b Effect of bull ($P < 0.05$).

The low number of inseminations per bull limits the power to detect statistically significant differences in sexed semen AI pregnancy rates among bulls. Therefore, we don't know if the differences are due to sorting damage, differences in bull fertility, or differences in cows that are inseminated.

Delaying insemination in fixed time AI systems does not help. Preliminary data from our research station demonstrated no difference between pregnancy rates to FTAI at 72 h compared to 80 h in the 5-day CO-Synch + CIDR system in postpartum cows (Hall, unpublished data). Similarly, Nebraska researchers found no significant differences in pregnancy rate in heifers inseminated at three different times relative to observed estrus. The optimum time of insemination with sexed semen after estrus or in a fixed time AI program remains to be determined.

PREGNANCY RATE IMPROVEMENTS ON THE WAY

As with any new technology, advancements continue with increased usage of sexed semen. Two recent advances should impact success with sexed semen this spring.

1. Missouri researchers demonstrated that delaying insemination by 20 hours in cows that did not express estrus by time of FTAI improved pregnancy rates to sexed semen by 13% (Thomas et al., 2013). Cows were synchronized using the 7-day CO-Synch + CIDR protocol, and all cows were given GnRH at 66 h, and cows that had exhibited estrus were inseminated at that time. Cows not exhibiting estrus were inseminated 20 h after GnRH.

2. A change or additive to the sorting process is increasing pregnancy rates by 5%. This change is very new and of a proprietary nature; however, data shared from AI companies clearly demonstrate increased pregnancy rates.

APPLICATIONS OF SEXED SEMEN IN COMMERCIAL BEEF PRODUCTION SYSTEMS

Development of maternal lines

The value of crossbred females in the commercial cowherd is well documented (Gregory and Cundiff, 1980; Cundiff and Gregory, 1999). However, crossbreeding continues to decrease in the US cow herd predominately due to complexities of many cross breeding systems, the need for separate herds, use of multiple breeds of bulls, limited cow herd size, and variation in calf crop. Even a simple two breed rotational cross is difficult in small herds or results in excessive variation in calf uniformity. In contrast, competing meat species make considerable use of maternal and terminal lines. Sexed semen provides the opportunity to use a small number of elite cows to generate replacements while mating the remainder of the cows to terminal sires.

Over the past five years, our research station has employed X-sorted semen on 20% of our cows to generate Angus X Hereford heifers. In this paradigm, cows are identified as candidates as “heifer dams” before the breeding season based on performance records, visual appraisal, and, in the near future, custom EPD’s. These “elite” cows are bred once by fixed-time AI to X-sorted semen followed by natural mating to a maternal type bull. Cows pregnant to sexed semen consistently produced calves that were 90% to 92% female. Overall, calves from this group of females were 62% to 78% female (Hall et al., 2010; Hall, unpublished data; Table 1). The remaining cows are mated to terminal type Angus, SimAngus, and Simmental sires.

Utilizing the sexed semen maternal line strategy to produce replacement females could reduce proportion of the herd dedicated to generating replacements. In a typical, commercial production setting where 15% of the cows are replaced and overall pregnancy rate is 90%, it

takes one third of the herd to be mated to maternal sires to generate replacements. If the gender ratio of offspring born to cows dedicated to producing replacements could be shifted to 66:34 female to male by FTAI with sexed semen followed with natural service, then only 25% of the cowherd is needed for replacements. Using sexed semen after detected estrus over three cycles may shift the ratio to 83% female:17% male. With this ratio, only 20% of the herd is needed to generate replacements and only 9% to 12% of the steers are maternal-type genetic influenced.

Table 1. Impact of semen type on gender ratios and performance of female calves.

	Year 1		**Year 2**		**Year 3**	
Semen Type	**Sexed**	**Con**	**Sexed**	**Con**	**Sexed**	**Con**
Female to Male Ratio	**78:22**	**47:53**	**68:31**	**50:50**	**62:38**	**56:44**
Growth Performance, kg (lb)*	**259.8 (572.8)**	**258.7 (570.4)**	**277.7 (612.3)**	**273.2 (602.4)**	**277.0 (610.8)**	**271.8 (599.3)**

Sexed = X-sorted, Con = conventional; *205 day adjusted weight

Heifer-Heifer System

In the Heifer-Heifer system, all replacement heifers are inseminated with X-sorted semen to produce the next generation of replacement females which allows the mature cows to be bred to terminal type sires. Identification of heifers with superior genetics to propagate replacements is more challenging in commercial than purebred herds. However, excellent production records, development of EPDs for commercial cows, and marker assisted selection may enhance the probability of selecting genetically superior heifers. Genetically, use of X-sorted semen in replacement heifers could decrease the generation interval and, potentially, enhance genetic progress.

Physiologically, use of X-sorted semen should reduce dystocia in heifers as there is an increased incidence of dystocia in dams giving birth to male calves (Bellows et al., 1971). Combining X-sorted semen with selection of bulls with low birth weight EPDs or positive calving ease EPDs could further reduce the incidence of dystocia.

A significant concern of the Heifer-Heifer System is the impact of reduced 1st service conception rate on calving distribution. There is considerable economic and biological advantage to heifers that calve in the first 21 days of their initial calving season (Lesmeister, 1973; Kill et al., 2012). Inseminating only heifers that are detected in estrus with X-sorted semen would maximize pregnancy rates to sexed semen, but additional heifers would have to be retained to compensate for the reduced pregnancy rates. However, open yearling heifers marketed through retained ownership have been profitable in recent years. Alternatively, breeding heifers with X-sorted semen after observed estrus over three estrous cycles may be

an option for producers of commercial bred heifers because the variation in expected calving dates of heifers may match calving seasons of diverse customers.

Shifting Gender Ratios to Enhance Marketing

Steers weigh more at weaning and are worth more per pound than their heifer cohorts (USDA-AMS, 2012). Altering the steer to heifer ratio in favor of steers may increase returns per cow. However, this may be offset by a reduction in calves born early in the calving season which results in decreased average weaning weight.

Increasing the percentage of steers marketed may be of particular advantage to beef producers with less than 200 cows. These producers are often unable to offer single sex tractor-trailer load lots of weaned vaccinated calves which currently command a premium in the market. The increased value of a steer compared to a heifer as well as the $35 to $75 per animal premium for weaned vaccinated cattle may more than compensate for increased semen costs and decreased weaning weights.

For the past three years, we synchronized postpartum cows using the 5-day CO-Synch + CIDR protocol and inseminated by fixed-time AI with Y-sorted semen from one of 9 bulls. Pregnancy rates were a disappointing 38%; however, calving data from the first two years resulted in a steer to heifer ratio of 65:35. Steers averaged 60 lbs heavier and 5 days older at weaning than heifer calves. In addition, we are gaining more information on the impact of repeated whole herd use of sexed semen on retention of cows in the cow herd. The average calving date of the herd has moved about 5 days later; however, this is confounded by a portion of cows going out to range for two years of the study. At University of Idaho, we consider this an exciting project; however, this application has high risk, and more information is needed from research and field studies.

Economics

Previously, several authors addressed the economics of the use of sexed semen (Hohenboken, 1999; Seidel, 2003). Review of these papers will provide information on assumptions that may need to be included in economic analysis of the feasibility of use of sexed semen for an individual ranch. Calculations on the economics of use of sexed semen in production of bred heifers are probably the most accurate. Management of yearling heifers bred with conventional or sexed semen is similar with only pregnancy rates and semen cost as primary variables. Meyer and co-workers (2012) reported a net increase in cost of $44.00 per pregnant heifer for heifers bred with sexed compared to conventional semen.

At UI NMCREEC, using sexed semen to produce a calf crop that is 65:35 male to female ratio allows us to market 2 tractor trailer loads of steers instead of 1 tractor trailer load of steers and 1 smaller load of heifers (or a split-sex load). For producers with about 120 to 150 cows, there may be a positive economic impact to using sexed semen to produce more steers.

Actual data from a local ranch selling on Superior Livestock Auction in 2013 is shown in Table 2. This rancher has 130 cows and sells a split load of steers and heifers. The load sells with heifers priced at $10/cwt below steers. Data from the entire sale indicated that heifers were probably valued at $13/cwt less than steers; therefore, his steers may also have been discounted. The split load line shows what he actually received. The two whole load lines indicate what he would have received for a full load of steers or a full load of steer without the $3/cwt discount.

Table 2. Impact of mixed sex and all steer loads on returns to ranch.

	Steers/heifers (hd)	Steer Wt. [Heifer wt.] (lbs/hd)	Steer Price [Heifer Price] ($/cwt)	Total load value	All Steer Impact
Split load	55/35	580 [520]	160 [150]	$78,340	
Whole load	90/0	580	160	$83,520	$5,180
Whole load	90/0	580	163	$85,086	$6,746

Would using sexed semen to increase the number of steers available for marketing be a positive economic decision for this ranch? If this ranch was already using AI then using sexed semen would increase costs by about $2250 (assuming $15 more per unit for sexed compared to conventional semen). Any loss in weaning weight due to changes in calving distribution would be offset by more steers and use of terminal sires. The potential increase in income to this ranch would be $2,900 to $4,500.

Estimation of economic cost or benefit of using sexed semen in postpartum cows is highly speculative and dependent on a number of factors including production costs, current AI usage, pregnancy rates to sexed semen, long-term impacts, production environment, and marketing advantages/opportunities.

What is really needed to properly discuss economic impacts of sexed semen is hard data based on actual field studies. Each individual ranch condition is different, and those differences are going to impact the value of sexed semen on that operation. For that reason rather than speculate on the value of these different applications, producers are encouraged to conduct their own cost/benefit analyses.

One of the best calculators for the cost and returns to using sexed semen can be found on the Genex Cooperative, Inc. website at:
http://documents.crinet.com/Genex-Cooperative-Inc/Beef/GenChoiceBeefQuickMath.pdf
This calculator is rather conservative so it gives a realistic analysis if inputs are listed honestly.

IMPLICATIONS

Sexed semen may be a useful part of a breeding program for commercial beef producers that are already using AI. The most feasible uses of sexed semen in commercial herds are:

1. Using X-sorted semen on "elite" cows to produce maternal lines that are efficient and well adapted to the individual ranch environment.

2. Breeding replacement heifers with X-sorted semen and allow all mature cows to be bred to terminal sires.

Use of Y-sorted semen to increase the percentage of steers produced has great potential, but at this point is to be considered a risky option.

Producers need to enter the project with the understanding that:

- Pregnancy rates to sexed semen are 10% to 20% below conventional semen.
- Sexed semen can be used in postpartum beef cows and heifers.
- Results with the use of sexed semen in pure fixed-time AI systems are often disappointing. However, estrus synchronization and AI systems that combine estrus detection and FTAI should be more successful.
- There is considerable variation in success with sexed semen.

Sexed semen has the potential to increase per cow beef production and returns by increasing the percentage of terminal-type steers produced either by creating maternal lines or shifting gender ratios. However, improvements in pregnancy rates to sexed semen will be needed.

The results of AI with sexed semen in beef heifers and cows indicate that application of sexed semen to the commercial beef industry is feasible. However, ranchers and consultants need to be cognoscente of the relative risk to reward ratio for this technology, and its subsequent impact on production costs, income, and calving distribution must be considered.

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